



**Happiness takes risk. Your lighting controls don't have to.**

## **Enlighted's Wireless Architecture**

*eliminates performance vulnerabilities when relying on wireless for controls.*

## **The Best of Both Worlds: a *physically-wired* connection for critical functions (controls) and *wireless* functionality for non-critical reporting (data collection, monitoring, analytics).**

**While other “intelligent lighting systems” completely rely on the wireless network to control lighting from a centralized or distributed system, Enlighted’s Smart Sensors are hard-wired to each individual fixture.**

Enlighted’s intelligent lighting controls solution hardwires control over dimming and other functional aspects of lighting, while using its wireless network for monitoring and data collection. In this way, lighting performance is independent of wireless network performance. Once loaded with their individual automation profiles, Enlighted’s Smart Sensors make locally optimized decisions ensuring safety, occupant comfort and energy savings in a distributed, fault-tolerant architecture.

Other lighting control systems completely rely on the wireless network to control equipment at the light fixture from a centralized or distributed system. As a result, they are prone to malfunction when the wireless network suffers from RF interference and disruptions. Should an Enlighted wireless network be disrupted, there may be a delay in data transmissions, but lighting levels and resultant energy savings would be preserved. Furthermore, Enlighted Smart Sensor transmissions place only minimum requirements on the network in terms of latency and bandwidth.

**The No Disruption Solution: With a centralized control system, if the wireless controller is malfunctioning or simply powered off, the lighting system does not work. With Enlighted’s distributed system, lighting control maintains performance when the wireless network is down. Energy savings, occupant comfort, and productivity are not disrupted. Nor are facility or IT teams.**

### **ZigBee and Wi-Fi’s Problematic Co-existence**

Wi-Fi (IEEE 802.11 WLAN) and ZigBee (IEEE 802.15.4 WPAN) operate in the 2.4GHz license-exempt band. Wi-Fi is designed for Internet access, video streaming, etc., whereas ZigBee targets low duty-cycle monitoring and control applications such as health care and home/industrial automation. They may run simultaneously and in close proximity within buildings. Signal interference between Wi-Fi and ZigBee has been extensively reported by both industry groups and academic research communities. Under light Wi-Fi traffic, ZigBee is known to suffer less from collision with Wi-Fi and can recover loss via retransmission [2], [3]. However, under moderate to high Wi-Fi traffic, ZigBee performance has proven to be less reliable. Furthermore, a channel assignment strategy does not work with modern Wi-Fi implementations that are channel bond (for 802.11n) and channel hop using up the entire spectrum.

### **Enlighted’s Enhancements for Better Co-existence with Wi-Fi**

ZigBee/IEEE 802.15.4 chip vendors have data rates available up to 2Mbps – more than 8 times the 250Kbps limitation imposed by ZigBee. Enlighted leverages this higher data rate to improve network performance. With ZigBee/IEEE 802.15.4 chips, air is shared. The less amount of time medium and large packets are in the air, the possibility for transmission to be interrupted (by signal collision and available bandwidth reductions) is greatly reduced.

**The Enlighted Wireless Network is designed to consume very little airtime (data transmission only), thus reducing the probability of collision with Wi-Fi traffic.**

## History

Enlighted was founded by networking experts who have worked at companies like Cisco, Cabletron, 3COM, Novell, Intel, Tropos and Trapeze with decades of experience in scalable, reliable and secure networking. The Enlighted team evaluated all of the known state-of-the-art Ethernet, Powerline and wireless networking options before deciding upon an approach. When they weighed ease of deployment, power consumption, security, robustness and cost, the wireless option struck the best balance of these factors.

The Enlighted Wireless Network is based on the IEEE 802.15.4 standard and operates in the 2.4 GHz ISM spectrum. As an open standard, IEEE 802.15.4 is one of the only reliable and low cost networking options available today.

## Future Compatibility of Enlighted’s Architecture / Upgradeability

**Enlighted uses hardware supporting a version of IEEE 802.15.4 that is capable of being upgraded to support ZigBee/ZigBee PRO and 6LoWPAN network stacks in the future.**

## Summary

	Enlighted	ZigBee	Comments
Physical and MAC layer	IEEE 802.15.4	IEEE 802.15.4	Standard – for 6LoWPAN also
Data Rate (100 byte airtime)	1 Mbps (1 ms)	250 Kbps (4 ms)	Lower data rate causes 4x the interference with Wi-Fi because packets are in the air longer
Security	AES-128	AES-128	Very secure encryption
Solution Architecture Benefits	<b>Distributed</b> - No network dependency - Immune to interference	Controller based - Network dependent - Interference can cause failure	Makes the wireless issue moot
Upgradability	<b>Fully upgradeable</b> software. Network stack can be replaced by ZigBee, 6LoWPAN, other	End-points have limited upgradeability	As standards converge, Enlighted’s deployed HW is ready to support them

## References

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